

Requested Patent: EP0294770A2

Title: IMPACT POLYPROPYLENE. ;

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Applicant(s): UNION CARBIDE CORP (US) ;

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Equivalents:

CA1313282, DE3865743D, ES2025732T, GR3003633T, JP1054045, JP7049500B,
KR9204893, US4812526

ABSTRACT:

An impact polypropylene composition comprising: (i) isotactic polypropylene; and (ii) a copolymer of ethylene and an alpha-olefin comonomer having 3 to 8 carbon atoms, said copolymer (a) having a density of about 0.87 to about 0.90 gram per cubic centimeter and a crystallinity in the range of about 20 to about 35 percent by weight based on the weight of the copolymer and (b) being present in the composition in the range of about 20 to about 50 percent by weight based on the weight of the polypropylene.



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(54) **Impact polypropylene.**

(57) **An impact polypropylene composition comprising:**

(i) isotactic polypropylene; and

(ii) a copolymer of ethylene and an alpha-olefin comonomer having 3 to 8 carbon atoms, said copolymer (a) having a density of about 0.87 to about 0.90 gram per cubic centimeter and a crystallinity in the range of about 20 to about 35 percent by weight based on the weight of the copolymer and (b) being present in the composition in the range of about 20 to about 50 percent by weight based on the weight of the polypropylene.

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IMPACT POLYPROPYLENE

Technical Field

This invention relates to an improved version of impact polypropylene.

Background Art

Impact polypropylene is widely used in such applications as appliances, automobiles, furniture, and luggage. It is generally a blend of isotactic polypropylene with ethylene/propylene or ethylene/propylene/diene rubbers or a similar combination prepared in situ. The rubber modifier overcomes the low temperature brittleness and the lack of impact resistance of the isotactic polypropylene. However, when the polypropylene is modified with an amorphous rubber, it experiences a severe stress whitening or blush on impact, e.g., when an object made of this impact polypropylene is struck, a white discoloration appears. This is obviously undesirable as it limits the applications of the impact polypropylene.

Disclosure of the Invention

An object of this invention, therefore, is to provide a polypropylene, which exhibits much reduced blushing together with high impact resistance.

Other objects and advantages will become apparent hereinafter.

According to the present invention, the above object is met by a composition comprising the following components:

- (i) isotactic polypropylene; and
- (ii) a copolymer of ethylene and an alpha-olefin comonomer having 3 to 8 carbon atoms, said copolymer (a) having a density of about 0.87 to about 0.90 gram per cubic centimeter and a crystallinity in the range of about 10 to about 30 percent by weight based on the weight of the copolymer and (b) being present in the composition in a range of about 20 to about 50 percent by weight based on the weight of the polypropylene.

Detailed Description

Isotactic polypropylene homopolymer can be prepared by the process described in United States patent 4,304,891, issued on December 8, 1981, which is incorporated by reference herein. The homopolymer preferably has a melt flow in the range of about 1 to about 20 and xylene solubles in the range of about 2 to about 6.

The ethylene/alpha-olefin copolymer is the result of the copolymerization of ethylene and an alpha-olefin comonomer having 3 to 8 carbon atoms. It can be prepared by the processes described in European Patent Application 0 120 501 and 0 120 503, both published on October 3, 1984 and incorporated by reference herein. The density of the copolymer is in the range of about 0.87 to about 0.90 gram per cubic centimeter. The portion of the copolymer attributed to the alpha-olefin comonomer is in the range of up to about 40 mole percent based on the total number of moles in the copolymer and is preferably in the range of about 7 to about 30 mole percent. The balance of the copolymer is based on ethylene. The preferred comonomers are propylene, 1-butene, 1-hexene, and 1-octene. The portion of the copolymer based on comonomer is in the range of about 15 to about 60 percent by weight based on the weight of the copolymer, and is preferably in the range of about 20 to about 45 percent by weight. These ethylene/alpha-olefin copolymers are considered to be soft polymers because they are semi-crystalline. The crystallinity is in the range of about 20 to about 35 percent by weight. The copolymer has a melt index in the range of about 0.1 to about 10 grams per 10 minutes and preferably in the range of about 0.3 to about 1.0 gram per 10 minutes. Melt index is determined by ASTM D-1238, Condition E. It is measured at 190° C. The isotactic polypropylene and the ethylene/alpha-olefin copolymers are, of course, not reactive with one another.

Subject composition can be prepared either by physical blending or in situ incorporation of the copolymer in a polypropylene matrix. The proportion of ethylene/alpha-olefin copolymer can be in the range

of about 20 percent by weight to about 50 percent by weight based on the weight of the isotactic polypropylene.

A typical blending technique is described as follows: isotactic polypropylene is mixed (dry) with the ethylene/propylene copolymer and the dry mixture is extruded at about 200 °C and pelleted. Conventional stabilizers for the isotactic polypropylene and the ethylene/propylene copolymers are used.

A typical in-situ method is carried out in the following manner: isotactic polypropylene homopolymer is prepared in one reactor and is transferred to another reactor (or reactors) where the ethylene/propylene copolymer is produced in the presence of the polypropylene homopolymer. The in-situ mixture is taken out of the reactor(s), stabilized, and extruded at about 200 °C and pelleted.

Various conventional additives can be added in conventional amounts to subject compositions such as antioxidants, ultraviolet absorbers, antistatic agents, pigments, dyes, fillers including carbon black, slip agents, fire retardants, stabilizers and smoke inhibitors.

The invention is illustrated by the following examples:

Examples 1 to 6

A polypropylene homopolymer having a melt flow of 4.0 and xylene solubles of 3.5 is blended with an ethylene/propylene copolymer or an ethylene/1-butene copolymer wherein the portion of the copolymer based on comonomer, propylene or 1-butene, is present in amounts of 25 and 15 percent by weight, respectively, based on the weight of the copolymer. The copolymer is present in the blend in an amount of 15 to 50 percent by weight based on the weight of the polypropylene. The blend is extruded and pelletized with the following stabilizers: 0.125 weight percent calcium stearate and 0.125 weight percent antioxidant. The pellets are injection molded into 125 mil specimens for evaluation.

The Table sets forth the variables, i.e., the weight percent of the copolymer based on the weight of the composition; the density of the copolymer in gram per cubic centimeter; and the crystallinity in percent by weight, and the results.

The tests used to obtain the results are as follows:

1. The Gardner Impact (-30 °C) test is carried out according to ASTM D-3029. This test involves dropping a weight from a defined height onto an injection molded disk, 125 mil thick, which has been preconditioned at -30 °C. The results are given in inch-pounds (inch-lbs).

2. The 1% SFM (Secant Flexural Modulus) test is carried out according to ASTM D-780. The results are given in pounds per square inch (psi).

3. The blushing (10 lbs) test is carried out as follows. An injection molded disk is used. The apparatus is the same as for the Gardner Impact test except that the falling weight (a steel bar) is 10 pounds. The steel bar is dropped on the disk. The disk is then aged at room temperature for 24 hours. Stress-whitening or blushing appears on the disk in the form a circle. The extent of stress-whitening is defined by the diameter of the circle measured in fractions of an inch (in).

4. Crystallinity is measured by Differential Scanning Colorimeter (DSC) using a Dupont 990 analyzer with a pressure DSC cell.

Table

Examples	Comonomer	% Co-Polymer	Density (g/cc)	Crystallinity (% by wt.)	Gardner Impact (inch-lbs)	1% SFM (psi)	Blushing (10 lb)(in)
1	propylene	30	0.88	<2	>320	110,000	0.63
2	propylene	15	0.87	20	20	160,000	0.5
3	1-butene	30	0.87	20	>300	125,000	0.4
4	1-butene	50	0.87	20	>320	88,000	0.0
5	1-butene	30	0.90	35	175	120,000	0.26
6	1-butene	30	0.92	45	20	130,000	<0.1
7.	1-butene	30	0.98	89	<10	188,000	0.0

Melt flow is determined in accordance with ASTM-1638.

Xylene solubles are defined as the fraction that stays in solution after the polypropylene sample is dissolved in hot xylene and the solution is allowed to cool to 23 °C.

5 Claims

1. An impact polypropylene composition comprising:
 - (i) isotactic polypropylene; and
 - (ii) a copolymer of ethylene and an alpha-olefin comonomer having 3 to 8 carbon atoms, said
- 10 copolymer (a) having a density of about 0.87 to about 0.90 gram per cubic centimeter and a crystallinity in the range of about 20 to about 35 percent by weight based on the weight of the copolymer and (b) being present in the composition in the range of about 20 to about 50 percent by weight based on the weight of the polypropylene.
2. The composition defined in claim 1 wherein the molded product thereof exhibits a blush of at most
- 15 about 0.5 inch per 10 pounds.
3. The composition defined in one or both of the claims 1 to 2 wherein the portion of the copolymer based on comonomer is present in the range of about 15 to about 60 percent by weight based on the weight of the copolymer.
4. The composition defined in claim 3 wherein the portion of the copolymer based on comonomer is
- 20 present in the range of about 20 to about 45 percent by weight based on the weight of the copolymer.
5. The composition defined in one or more of the claims 1 to 4 wherein the comonomer is 1-butene.
6. The composition defined in one or more of the claims 1 to 4 wherein the comonomer is propylene.

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ABSTRACT:

An impact polypropylene composition comprising: (i) isotactic polypropylene; and (ii) a copolymer of ethylene and an alpha-olefin comonomer having 3 to 8 carbon atoms, said copolymer (a) having a density of about 0.87 to about 0.90 gram per cubic centimeter and a crystallinity in the range of about 20 to about 35 percent by weight based on the weight of the copolymer and (b) being present in the composition in the range of about 20 to about 50 percent by weight based on the weight of the polypropylene.

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(56) References cited:
EP-A- 0 052 657
EP-A- 0 168 129
GB-A- 1 346 234
GB-A- 2 050 658
GB-A- 2 063 278

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Description

This invention relates to an improved version of impact polypropylene, particularly a product molded therefrom.

Impact polypropylene is widely used in such applications as appliances, automobiles, furniture, and luggage. It is generally a blend of isotactic polypropylene with ethylene/propylene or ethylene/propylene/diene rubbers or a similar combination prepared in situ. The rubber modifier overcomes the low temperature brittleness and the lack of impact resistance of the isotactic polypropylene. However, when the polypropylene is modified with an amorphous rubber, it experiences a severe stress whitening or bluish on impact, e.g., when an object made of this impact polypropylene is struck, a white discoloration appears. This is obviously undesirable as it limits the applications of the impact polypropylene.

GB-A-2 060 658 and 2 063 278 describe compositions for the production of cold drawn film. Said compositions comprise an ethylene- α -olefin copolymer elastomer having a density of not more than 0.91 g/cm³ and at least one polymer selected from crystalline polypropylene and polybutene-1 as essential components.

EP-A-168 129 is directed to a polypropylene composition having superior clarity and good low-temperature impact resistance and comprising crystalline polypropylene and ethylene-propylene random copolymer containing at least 70 wt % of ethylene.

An object of this invention is to provide a molded product of polypropylene, which exhibits much reduced blushing together with high impact resistance.

Other objects and advantages will become apparent hereinafter.

According to the present invention, the above object is met by a product molded from a composition comprising the following components:

- (i) isotactic polypropylene; and
- (ii) a copolymer of ethylene and 1-butene, said copolymer (a) having a density of about 0.87 to about 0.90 gram per cubic centimeter and a crystallinity in the range of about 20 to about 35 percent by weight based on the weight of the copolymer and (b) being present in the composition in a range of about 20 to about 50 percent by weight based on the weight of the polypropylene.

Isotactic polypropylene homopolymer can be prepared by the process described in US-A-4,304,891. The homopolymer preferably has a melt flow in the range of about 1 to about 20 and xylene solubles in the range of about 2 to about 6.

The ethylene/1-butene copolymer can be prepared by the processes described in EP-A-120 501 and 120 503. The density of the copolymer is in the range of about 0.87 to about 0.90 gram per cubic centimeter. The portion of the copolymer attributed to the comonomer (1-butene) is in the range of up to about 40 mole percent based on the total number of moles in the copolymer and is preferably in the range of about 7 to about 30 mole percent. The balance of the copolymer is based on ethylene. The portion of the copolymer based on 1-butene is in the range of about 15 to about 60 percent by weight based on the weight of the copolymer, and is preferably in the range of about 20 to about 45 percent by weight. These ethylene/1-butene copolymers are considered to be soft polymers because they are semi-crystalline. The crystallinity is in the range of about 20 to about 35 percent by weight. The copolymer has a melt index in the range of about 0.1 to about 10 grams per 10 minutes and preferably in the range of about 0.3 to about 1.0 gram per 10 minutes. Melt index is determined by ASTM D-1238, Condition E. It is measured at 190 °C. The isotactic polypropylene and the ethylene/1-butene copolymers are, of course, not reactive with one another.

Subject composition can be prepared either by physical blending or in situ incorporation of the copolymer in a polypropylene matrix. The proportion of ethylene/1-butene copolymer can be in the range of about 20 percent by weight to about 50 percent by weight based on the weight of the isotactic polypropylene.

A typical blending technique is described as follows: isotactic polypropylene is mixed (dry) with the ethylene/1-butene copolymer and the dry mixture is extruded at about 200 °C and pelleted. Conventional stabilizers for the isotactic polypropylene and the ethylene/1-butene copolymers are used.

A typical in-situ method is carried out in the following manner: isotactic polypropylene homopolymer is prepared in one reactor and is transferred to another reactor (or reactors) where the ethylene/1-butene copolymer is produced in the presence of the polypropylene homopolymer. The in-situ mixture is taken out of the reactor(s), stabilized, and extruded at about 200 °C and pelleted.

Various conventional additives can be added in conventional amounts to subject compositions such as antioxidants, ultraviolet absorbers, antistatic agents, pigments, dyes, fillers including carbon black, slip agents, fire retardants, stabilizers and smoke inhibitors.

The invention is illustrated by the following examples:

Examples 1 to 6

5 A polypropylene homopolymer having a melt flow of 4.0 and xylene solubles of 3.5 is blended with an ethylene/propylene copolymer or an ethylene/1-butene copolymer wherein the portion of the copolymer based on comonomer, propylene or 1-butene, is present in amounts of 25 and 15 percent by weight, respectively, based on the weight of the copolymer. The copolymer is present in the blend in an amount of 15 to 50 percent by weight based on the weight of the polypropylene. The blend is extruded and pelletized
10 with the following stabilizers: 0.125 weight percent calcium stearate and 0.125 weight percent antioxidant. The pellets are injection molded into 3.175 mm (125 mil) specimens for evaluation.

The Table sets forth the variables, i.e., the weight percent of the copolymer based on the weight of the composition; the density of the copolymer in gram per cubic centimeter; and the crystallinity in percent by weight, and the results.

15 The tests used to obtain the results are as follows:

1. The Gardner Impact (-30° C) test is carried out according to ASTM D-3029. This test involves dropping a weight from a defined height onto an injection molded disk, 3.175 mm (125 mil) thick, which has been preconditioned at -30° C. The results are given in cm-kg (inch-lbs).
2. The 1% SFM (Secant Flexural Modulus) test is carried out according to ASTM D-780. The results are
20 given in MPa (psi).
3. The blushing [4.53 kg (10 lbs)] test is carried out as follows. An injection molded disk is used. The apparatus is the same as for the Gardner Impact test except that the falling weight (a steel bar) is 4.53 kg (10 pounds). The steel bar is dropped on the disk. The disk is then aged at room temperature for 24 hours. Stress-whitening or blushing appears on the disk in the form a circle. The extent of stress-whitening is defined by the diameter of the circle measured in fractions of a cm (in).
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4. Crystallinity is measured by Differential Scanning Colorimeter (DSC) using a Dupont 990 analyzer with a pressure DSC cell.

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Table

Example	Comonomer	% Co-Polymer	Density (g/cc)	Crystallinity (% by wt.)	Gardner Impact cm-kg (Inch-lbs)	1% SFM MPa (psi)	Blushing at 4.53kg cm (in)
1*	propylene	30	0.86	<2	>368 (>320)	760 (110,000)	1.80 (0.63)
2*	propylene	15	0.87	20	23 (20)	1,100 (160,000)	1.27 (0.5)
3	1-butene	30	0.87	20	>345 (>300)	860 (125,000)	1.02 (0.4)
4	1-butene	50	0.87	20	>345 (>320)	590 (88,000)	0.0 (0.0)
5	1-butene	30	0.80	35	201 (176)	830 (120,000)	0.86 (0.26)
6*	1-butene	30	0.82	45	23 (20)	900 (130,000)	<0.25 (<0.1)
7*	1-butene	30	0.88	89	<12 (<10)	1,280 (188,000)	0.0 (0.0)

* = Comparative

Melt flow is determined in accordance with ASTM-1638.

Xylene solubles are defined as the fraction that stays in solution after the polypropylene sample is dissolved in hot xylene and the solution is allowed to cool to 23 °C.

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Claims

1. Product molded from a composition comprising:
 - (i) isotactic polypropylene; and
 - 10 (ii) a copolymer of ethylene and 1-butene, said copolymer (a) having a density of about 0.87 to about 0.90 gram per cubic centimeter and a crystallinity in the range of about 20 to about 35 percent by weight based on the weight of the copolymer and (b) being present in the composition in the range of about 20 to about 50 percent by weight based on the weight of the polypropylene.
- 15 2. The molded product defined in claim 1, which exhibits a blush of at most about 1.27 cm (0.5 inch) per 4.53 kg (10 pounds).
3. The molded product defined in one or both of the claims 1 to 2 wherein the portion of the copolymer based on 1-butene is present in the range of about 15 to about 60 percent by weight based on the weight of the copolymer.
- 20 4. The molded product defined in claim 3 wherein the portion of the copolymer based on 1-butene is present in the range of about 20 to about 45 percent by weight based on the weight of the copolymer.

25 Revendications

1. Produit moulé à partir d'une composition comprenant :
 - (i) un polypropylène isotactique ; et
 - 30 (ii) un copolymère d'éthylène et de 1-butène, ledit copolymère (a) ayant une masse volumique d'environ 0,87 à environ 0,90 g/cm³ et une cristallinité comprise dans l'intervalle d'environ 20 à environ 35% en poids, sur la base du poids du copolymère, et (b) étant présent dans la composition en une quantité comprise dans l'intervalle d'environ 20 à environ 50% en poids, sur la base du poids du polypropylène.
- 35 2. Produit moulé suivant la revendication 1, qui présente un voile d'au plus environ 1,27 cm (0,5 in) pour 4,53 kg (10 lbs).
3. Produit moulé suivant l'une, ou bien l'une et l'autre, des revendications 1 et 2, dans lequel la portion du copolymère à base de 1-butène est présente en une quantité comprise dans l'intervalle d'environ 15 à environ 60% en poids, sur la base du poids du copolymère.
- 40 4. Produit moulé suivant la revendication 3, dans lequel la portion du copolymère à base de 1-butène est présente en une quantité comprise dans l'intervalle d'environ 20 à environ 45% en poids, sur la base du poids du copolymère.

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Patentansprüche

1. Produkt, geformt aus einer Zusammensetzung, die umfaßt:
 - (i) isotaktisches Polypropylen und
 - 50 (ii) ein Copolymer von Ethylen und 1-Buten, das (a) eine Dichte von etwa 0,87 bis etwa 0,90 g/cm³ und eine Kristallinität im Bereich von etwa 20 bis etwa 35 Gew.-%, bezogen auf das Gewicht des Copolymers, hat und (b) in der Zusammensetzung in einer Menge von etwa 20 bis etwa 50 Gew.-%, bezogen auf das Gewicht des Polypropylens, vorliegt.
- 55 2. Formprodukt gemäß Anspruch 1, das ein Anlaufen von höchstens etwa 1,27 cm (0,5 inch) pro 4,53 kg (10 pounds) zeigt.
3. Formprodukt gemäß einem oder beiden der Ansprüche 1 bis 2, worin der Anteil des auf 1-Buten

basierenden Copolymers im Bereich von etwa 15 bis etwa 60 Gew.-%, bezogen auf das Gewicht des Copolymers, vorliegt.

4. Formprodukt gemäß Anspruch 3, worin der Anteil des auf 1-Buten basierenden Copolymers im Bereich von etwa 20 bis etwa 45 Gew.-%, bezogen auf das Gewicht des Copolymers, vorliegt.

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(56) Tape yarn of polyester/polypropylene resin blend and carpet backing woven therefrom.

(57) Tape yarns suitable for weaving, particularly into primary carpet backing fabrics for tufted carpet tiles and automotive carpets, are composed of polyester/polyolefin resin blends and prepared by spinning and drawing films extruded from such blends.

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TAPE YARN OF POLYESTER/POLYPROPYLENE RESIN BLEND AND CARPET BACKING WOVEN THEREFROM

Field of the Invention

This invention relates to tape yarns suitable for weaving, comprising a resin blend of polyester and propylene-polymer components, and carpet backings woven from such yarns. The invention also relates to a resin blend suitable for manufacture of tape yarns and a process for producing the yarns.

Background of the Invention

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Manufacture of tufted carpets normally involves tufting a primary backing followed by washing, drying and drying the tufted backing and then subjecting the same to a finishing operation.

Tufting usually is accomplished by inserting reciprocating needles threaded with yarn through the primary backing to form tufts or loops of yarn. Loopers or hooks, typically working in timed relationship with the needles, are located such that the loopers are positioned just above the needle eye when the needles are at an extreme point in their stroke through the backing fabric. When the needles reach that point, yarn is picked up from the needles by the loopers and held briefly. Loops or tufts of yarn result from passage of the needles back through the primary backing. This process typically is repeated as the loops move away from the loopers due to advancement of the backing through the needling apparatus. If desired, the loops can be cut to form a cut pile; for example by using a looper and knife combination in the tufting process. Alternatively, the loops can remain uncut.

Primary backings for tufted carpets are typically woven or nonwoven fabrics made of one or more natural or synthetic fibers or yarns such as jute, polypropylene, polyethylene, polyamides, polyesters and rayon. Films of synthetic materials, such as polypropylene, polyethylene and ethylene-propylene copolymers, also can be used to form a primary backing.

The tufts of yarn inserted in the tufting process are usually held in place by untwisting of the yarns as well as shrinkage of the backing. In the finishing operation, the back side or stitched surface of the backing usually is coated with an adhesive, such as a natural or synthetic rubber or resin latex or emulsion or a hot melt adhesive, to enhance locking or anchoring of tufts to the backing. Use of such adhesives also improves dimensional stability of the tufted carpet, resulting in more durable carpets of improved skid and slip resistance. The tufted carpet often is further stabilized in the finishing operation by laminating a secondary backing, for example a thermoplastic film or a woven or nonwoven fabric made from polypropylene, polyethylene or ethylene-propylene copolymer or natural fibers, such as jute, to the primary backing. The adhesive used in the finishing operation bonds the primary backing to the secondary backing.

Carpet backings woven from polypropylene yarns are well known and widely used commercially. An example of such a backing is disclosed in U.S. Patent 3,110,905 to Rhodes, issued November 19, 1963, which is directed to backings woven from yarns of flat, rectangular, cross-section of thermoplastic resins, including polypropylene, for tufted carpets. Manufacture of such yarns and use of the same to manufacture woven carpet backings is disclosed in U.S. 3,503,106, issued March 31, 1970, to Port et al., directed to extrusion of thermoplastic resins to form a film-like web, orienting the film by stretching, slitting the oriented films into tape or ribbon-like yarns, folding the tapes, calendering the folded tapes and then feeding the tapes to a loom for weaving. Such flat, rectangular yarns are often referred to as tape or ribbon yarns.

For some end uses, backings woven from polypropylene tape yarns have found limited use. In automotive carpets, woven polypropylene backings have limited utility because molding of the carpet to automobile interior surfaces often is conducted above the melting point of polypropylene or at temperatures high enough to cause stretching of polypropylene yarns and loss of dimensional stability. Woven polypropylene backings are not favored for use in carpet tile for similar reasons. When carpet tiles are adhered to surfaces using hot melt adhesives, heating to activate such adhesives often is performed at temperatures high enough to cause stretching of the backing yarns such that dimensional stability is sacrificed.

For automotive carpets, carpet tiles and other carpet structures to be exposed to temperatures above the melting point of polypropylene or high enough to cause stretching of polypropylene yarns, backings woven from other materials are known. However, higher melting materials pose other difficulties. Woven polyester backings for automotive carpets and carpet tile have been proposed. Polyester yarns can

withstand temperatures higher than polypropylene yarns without substantial loss of dimensional stability; however, backings woven from polyester tape yarns are poorly suited for manufacture of tufted carpets because the yarns are brittle and abrasive such that substantial deflection and breakage of both needles and yarns occurs during tufting, resulting in poor carpet quality.

U.S. Patent No. 4,558,602, issued December 3, 1988, discloses polypropylene backings for carpets and carpet tiles having woven reinforcing yarns less prone to stretching than polypropylene, preferably of nylon, polyester or fiberglass, in the warp direction. While dimensional stability of such carpets is improved relative to those prepared from polypropylene backings, other things being equal, incorporation of warp reinforcing yarns adds cost and complexity to manufacture of backings, and the reinforced backings may contain enough polypropylene yarns to lead to difficulties in high temperature processing.

Nonwoven polyester carpet backings also have been proposed and are commercially available. Such backings overcome the high temperature limitations of polypropylene backings. However, their random orientation of fibers within the nonwoven web, while reducing tufting difficulties experienced with woven polyester tape yarn backings, give the backings reduced dimensional stability relative to woven backings including those of polypropylene.

It will be appreciated from the above that it would be desirable to provide yarns and carpet backings woven therefrom wherein dimensional stability, high temperature processability and tuftability by conventional needling techniques are adequate to overcome the above described difficulties. It is an object of this invention to provide improved tape yarns suitable for manufacture of woven carpet backings for tufted carpets, including carpet tiles and automotive carpet. A further object of the invention is to provide such carpet backings and carpet structures containing the backings. Another object of the invention is to provide a resinous composition suitable for use in manufacture of such improved yarns and a process for manufacture of slit-film yarns from the resins. Other objects of the invention will be apparent to persons skilled in the art from the following description and claims.

I have now found that the objects of this invention can be attained by providing tape yarns of a polyester resin component and a substantially crystalline propylene polymer component in which proportions and melt rheology of the components are such that extruded films of good strength in the molten state and of sufficiently low stiffness, abrasion and brittleness for preparation of tape yarns can be obtained and in which the beneficial properties of the polyester component in terms of yarn strength, stiffness and dimensional stability are retained while sufficient splitting characteristics for good needle penetration in tufting operations also is achieved though not to such a degree that splitting of yarns weakens carpet backings woven from the yarns. The polyester and propylene polymer components of the invented yarns are incompatible, being present in the tape yarns as a two-phase system, and facilitate splitting of the yarns during needling. During processing of the resin into tape yarns, the polyester component, being of intermediate intrinsic viscosity and relatively low melt strength, is, in effect, supported in the melt by the relatively higher melt viscosity, molten propylene polymer component such that substantially uniform film thickness and good film strength are achieved. Advantageously, the yarns can be woven by conventional techniques into fabrics, including carpet backing fabrics of good strength and dimensional stability capable of withstanding higher processing temperatures than woven polypropylene backings without substantial loss of properties. Such carpet backing fabrics are easily penetrated by needles used in conventional carpet manufacturing processes. Accordingly, the backings are well suited for use in a variety of carpet structures and particularly useful in manufacture of carpet structures for carpet tile and automotive applications.

The Prior Art

As discussed above, U.S. Patent No. 4,558,602 issued December 3, 1988, is directed to improved woven polypropylene backings for use in carpets and carpet tiles in which reinforcing yarns are woven into the warp. While the patent recognizes problems of dimensional stability in woven polypropylene backings for carpet tiles, the solution according to the patent, incorporation of reinforcing yarns into such backings, does not suggest the present invention wherein yarns of a multi-phase resin are used to prepare backing structures.

Other patents and publications which may be of interest in connection with the present invention in disclosing various blends of polyester and polypropylene polymer resin components for various purposes are discussed below. Although such blends and various utilities therefor are disclosed, the problem of improving tuftability of polyester yarns for carpet backing structures to be used in applications, such as carpet tile and automotive carpets, having substantial requirements as to dimensional stability, high

temperature processability and tuftability by needling are not addressed.

U.S. 3,579,809, issued May 18, 1971, to Sevenich, is directed to improving flex resistance of poly(ethylene terephthalate) films used as packaging and magnetic recording tapes by blending minor amounts of fusible, heat stable polymers of mono-alpha olefins with the poly(ethylene terephthalate). According to the patent, 2-40 weight percent olefin polymer can be used although there is no advantage to adding more than about 15 weight percent. Polyethylene, polypropylene, polybutylene, poly-4-methyl pentene and polytetramethylene oxides are said to be most effective for improving flexibility in poly(ethylene terephthalate). It also is reported that the improved film appears to consist of elongated globules 0.1-5 microns thick by 0.25-8.5 microns wide of polyethylene imbedded in the polyester and that the resins are incompatible.

U.S. 3,604,196, issued September 14, 1971, to Prevorsek et al., is directed to fibers of up to 4 denier for use in making apparel fabrics. The fibers are composed of blends of incompatible polymers in which one or more polymer species is dispersed in a matrix of another species, specifically disclosed polymer blends being 50/25/25 and 40/30/30 polycapraamide/poly(ethylene terephthalate) /polypropylene, 70/30 polycapraamide/poly(ethylene terephthalate), and 35/65 polycapraamide/polypropylene. Yarns according to the patent exhibit irregular crimp and consist of a multitude of fine fibers of varying denier averaging 4 or less. The yarns are said to be suitable for stretch-type apparel. Other disclosed utilities are in draperies, upholstery, carpet, insulation and linen-like textiles. The fine fibers are produced by subjecting a splittable, elongated structure composed of a blend of the incompatible polymers to a rolling pressure down the length against one crosswise direction of the elongated structure maintained in semiamorphous state by maintaining temperature below the glass transition temperature of at least one of the blend components, and subjecting the semiamorphous structure to a transverse force gradient, such as by twisting, flexing, rubbing or tearing, to split the structure longitudinally into fine fibers.

U.S. 3,705,074 issued December 5, 1972, to Lamb et al., is directed to high bulk, soft yarns from monofilaments for use in apparel fabrics and discloses longitudinally oriented film or monofil consisting essentially of, and prepared by extruding, 50-90 percent fiber forming polymer selected from polyamides, polyesters and polyolefins or a mixture thereof and 5-50 percent polyester having a molecular weight too low for fiber strength. The low molecular weight polyester component has a reduced viscosity in metecrasol of 0.1-0.35 dl/g.

U.S. 3,707,837, issued January 2, 1973, to Gibbon is directed to a process for fibrillating fibrillatable tape at throughputs above 500 feet per minute to produce yarns of relatively soft handle, high tenacity, good cover, desirable luster and excellent printability having utility in knitting, weaving and tufting. The disclosed process, said to be applicable to any fibrillatable tape, comprises subjecting a travelling, fibrillatable tape under tension of about 0.05-0.2 grams per denier to the action of at least four fluid twisting means, such as a fluid jet, wherein the direction of twist imparted to the tape is completely reversed between adjacent twisting means. Prior to twisting, the tape is hot drawn to a draw ratio of about 3.3-4.2 at about 80-140° C, then subjected to a temperature of about 120-230° C for about 0.01-0.2 seconds, preferably to achieve a draw ratio of about 4-5.5. Fibrillation of tapes by other means, including contacting with a grooved roller, passage over a stationary brush or similar shredding means, piercing in a plurality of points and passing through a zone of high turbulence also is disclosed.

Preferred tapes in the process of Gibbon are said to comprise poly(ethylene terephthalate), and blends thereof with about 0.1-25 percent by weight incompatible polymer, based on weight of the poly(ethylene terephthalate), are disclosed. Preferred incompatible polymers are said to be polypropylene and polyethylene with the former being most preferred. The polypropylene must be finely dispersed throughout the poly(ethylene terephthalate) according to Gibbon, such dispersion being facilitated by use of poly(ethylene terephthalate) and polypropylene of about equal viscosities. The patent discloses that good dispersion is achieved by mixing and extruding at high temperature through a slit die poly(ethylene terephthalate) having intrinsic viscosity of about 0.45-0.75 containing about 0.5-5 percent polypropylene, by weight of poly(ethylene terephthalate), having a melt flow rate, according to ASTM D-1238 62T, Condition B or L, of about 8-22, at an extrusion temperature of about 280-300° C via a pack that imposes a shear force of about 60-150 reciprocal seconds for about 1-2 seconds.

Canadian Patent No. 980012, issued December 31, 1974, to Gibbon discloses fibrillating fibrillatable, 0.002-0.005 inch thick tapes of at least 90 weight percent poly(ethylene terephthalate) that have been drawn as described in the above-discussed U.S. patent to Gibbon. Blends of poly(ethylene terephthalate) with about 0.5-5 percent polypropylene, by weight of poly(ethylene terephthalate), wherein the poly(ethylene terephthalate) intrinsic viscosity is about 0.40-0.80 and polypropylene melt flow index, according to ASTM D-1238 62T Condition E or L, is about 8-22, and extrusion of such a blend as in the U.S. patent to Gibbon are disclosed. Advantages and utility of yarns also are as disclosed in the U.S. patent to Gibbon. Blends of

poly(ethylene terephthalate) and polypropylene as described in the U.S. patent to Gibbon also are disclosed in U.S. 4,036,003, issued July 19, 1977, to Lowder et al.; U.S. 4,123,490, issued October 31, 1978, to Gibbon; and U.S. 4,179,875, issued December 25, 1979, to Gibbon, all of which are directed to fibrillated tapes for use as sewing threads.

5. U.S. 4,368,295, issued January 11, 1983, to Newton et al., discloses oriented films, for use as paper substitutes, carbon paper and typewriter ribbon bases, in high speed printing applications, as textile threads, magnetic recording tape, packaging, laminates and identity cards, comprising linear polyester and 0.5-100 percent, by weight of polyester, of at least one olefin polymer (e.g., polyethylene, polypropylene, poly-4-methylpentene, ethylenepropylene copolymers) and 0.05-50 percent, by weight of the olefin polymer, of a carboxylated polyolefin. According to the patent, the carboxylated polyolefin is used to improve dispersion of the olefin polymer in the polyester, thereby avoiding streaks of clear regions that occur in otherwise opaque or translucent oriented films prepared from linear polyester/olefin polymer blends lacking the carboxylated component.

U.S. 4,547,420, issued October 15, 1985, to Krueger et al., is directed to bicomponent fibers, for use in making nonwoven fibrous webs, comprising first and second polymer components of generally similar melt viscosities wherein the first component is at least partially amorphous, but crystallizable, at a temperature below the melting point of the second component. Representative polymer combinations are said to include poly(ethylene terephthalate)/polypropylene and poly(ethylene terephthalate)/polyamide. Proportions of the components range from 40-60 to 60-40 volume percent.

20. Batalie et al., *Journal of Elastomers and Plastics*, 18, October, 1986, pages 228-233 reports results of a study of mechanical property and water permeability testing of compression molded plaques of blends of poly(ethylene terephthalate) and polypropylene in various proportions, noting that both resins are useful as geotextiles and that 80/20 blends of poly(ethylene terephthalate) and polypropylene are used in soft drink bottles and concluding that specific compositions may be attractive in selected applications such as geotextiles. The authors report, with respect to mechanical properties, "strong negative deviations from the rule of mixtures behavior, suggesting that the two polymers are poorly (weakly) bonded at domain contacts" and, with respect to water permeation, a more complicated diffusion path in the two component system.

While these patents and the publication describe various blends containing a polyester component and a polyolefin component, including propylene polymers, neither the poly(ethylene terephthalate)/propylene polymer blends according to this invention nor tape yarns comprising the same is taught or suggested, nor is utility of such yarns in woven carpet backings of good dimensional stability, high temperature processability and tuftability by needling.

Summary of the Invention

20. Briefly, the yarns of this invention are characterized by substantially flat, rectangular cross-section and comprise a resinous blend comprising a poly(ethylene terephthalate) component having dispersed therein about 17 to about 43 percent, by weight of the poly(ethylene terephthalate) component, of a substantially crystalline propylene polymer component.

Such yarns are produced by a process comprising (a) forming a molten, intimate mixture comprising a poly(ethylene terephthalate) component having intrinsic viscosity of about 0.7 to about 1.0 dl/g in o-chlorophenol, according to ASTM D-2857, and about 17 to about 43 percent, by weight of the poly(ethylene terephthalate) component, of a substantially crystalline propylene polymer component having a melt flow rate of about 2 to about 18 g/10 minutes, according to ASTM D-1238 Condition L, such mixture being substantially free of water; (b) extruding the molten mixture through a film die onto a chill roll to obtain a quenched film of substantially uniform thickness; (c) slitting the quenched film along its length into a plurality of tapes; and (d) drawing the tapes lengthwise at a draw ratio of about 4:1 to about 5.5:1.

50. Also provided according to the present invention are woven carpet backing fabrics for tufted carpet structures and, in particular, woven primary backing fabrics well suited for use in tufted carpet structures for carpet tile and automotive carpets. The carpet backing fabrics comprise woven warp and fill yarns, at least one of which comprise yarns of substantially flat, rectangular cross-section comprising a resinous blend of components comprising a poly(ethylene terephthalate) component having dispersed therein about 17 to about 43 percent, by weight of the poly(ethylene terephthalate) component, of a substantially crystalline propylene polymer component.

In a further embodiment, this invention provides a resin blend comprising a poly(ethylene terephthalate)

component having intrinsic viscosity of about 0.7 to about 1.0 dl/g in o-chlorophenol according to ASTM D-2857 and about 17 to about 43 percent, by weight of the poly(ethylene terephthalate) component, of a substantially crystalline propylene polymer component having a melt flow rate of about 2 to about 18 g/10 minutes according to ASTM D-1238 Condition L.

Detailed Description of the Invention

10 In greater detail, the yarns of this invention are characterized by substantially flat, rectangular cross-section of substantially uniform width and thickness along the length of the yarn. The yarns are composed primarily of a poly(ethylene terephthalate) component and also contain a minor amount of a substantially crystalline propylene component which is effective to allow the yarns to be easily penetrated by tufting needles used in carpet manufacture without excessive splitting and fibrillation and without substantial loss of
15 desirable yarn properties, such as stiffness and dimensional stability, imparted by the poly(ethylene terephthalate) component.

The poly(ethylene terephthalate) and propylene polymers are immiscible, as indicated by thermal analysis showing two discrete melting point peaks, and are believed to be present in the yarns in the form of a matrix or continuous phase of the poly(ethylene terephthalate) component having a discontinuous
20 phase of the propylene polymer component finely and substantially uniformly distributed therethrough.

The poly(ethylene terephthalate) component used in preparing the invented yarns is an intermediate intrinsic viscosity resin of the type commonly used in packaging and liquid container applications. The poly(ethylene terephthalate) component preferably is a homopolymer poly(ethylene terephthalate) although poly(ethylene terephthalate)-dominated copolyesters containing minor amounts of copolymerized acid or glycol
25 components or blends with other polyesters can be utilized provided that the copolyesters or blends exhibit suitable intrinsic viscosities and yarn properties. The poly(ethylene terephthalate) component can be prepared by known techniques. Commonly, terephthalic acid or a derivative thereof is esterified or transesterified by reaction with ethylene glycol. Blends of virgin poly(ethylene terephthalate) component with recycled resin from the invented process, e.g. edge trim, or regrind from poly(ethylene terephthalate) liquid
30 containers, e.g. soft drink bottles, also can be used. Propylene polymer content of recycled edge trim and intrinsic viscosity losses in the poly(ethylene terephthalate) component thereof as well as in bottle regrind resin must be accounted for in selecting the amount of recycle or regrind to be used.

Suitably, intrinsic viscosity of the poly(ethylene terephthalate) component ranges from about 0.7 to 1 dl/g in o-chlorophenol, determined according to ASTM D-2857. Higher intrinsic viscosity poly(ethylene terephthalate) resins are more difficult to process by extrusion and extruded films of such resins are less tractable than films of lower intrinsic viscosity resins such that slitting thereof into tapes is difficult. Poly(ethylene terephthalates) having intrinsic viscosity below about 0.7 dl/g are not suitable because they provide insufficient strength to yarns prepared therefrom for carpet backing applications. Further, hydrolysis of such resins during processing lowers molecular weight thereof with accompanying processing difficulties and losses in final product strength. Intrinsic viscosity of the poly(ethylene terephthalate) component used in
40 preparation of the invented yarns can decrease by up to about 0.15 dl/g when processed as in the invented process. Preferably, the poly(ethylene terephthalate) component from which the invented yarns are prepared have intrinsic viscosities of about 0.75 to about 0.85 dl/g in o-chlorophenol according to ASTM D-2857, as the same exhibit desirable melt processibility for film extrusion and tape manufacture according to the present invention, and are of high enough intrinsic viscosity to withstand some loss of molecular weight strength during processing such that yarns prepared from such resins in combination with effective amounts of propylene polymer component exhibit desirable yarn properties, including tensile strength and elongation.

Suitable poly(ethylene terephthalates) are commercially available. Examples include intermediate intrinsic viscosity grade polyesters available from The Goodyear Tire and Rubber Company under the name Cleartuf Polyester.

The propylene polymer component used in preparing the invented yarns is a substantially crystalline propylene homopolymer or copolymer of propylene with minor amounts, e.g., up to about 30 mole %, of one or more copolymerizable alpha-olefins such as ethylene, butene-1 and pentene-1. Such propylene
55 polymers are commercially available and typically prepared by polymerizing propylene or propylene and comonomer(s) in the presence of heterogeneous catalysts comprising a transition metal halide component, e.g., a supported or unsupported titanium chloride composition, and an organometallic component, e.g. an aluminum alkyl or alkyl aluminum chloride, at elevated temperatures and pressures and often in the

presence of agents for regulating molecular weight, for example, hydrogen. Electron donors often are used in such polymerization to reduce levels of amorphous propylene polymer produced during polymerization. A preferred propylene polymer component according to the present invention is substantially crystalline homopolymer polypropylene.

5 The propylene polymer component has a melt flow rate according to ASTM D-1238 Condition L of about 2 to about 18 g/10 minutes. The component provides melt strength to the poly(ethylene terephthalate) component used according to the present invention at temperatures and other conditions employed in preparation of yarns according to this invention, thereby facilitating extrusion of films of substantially uniform thickness and substantially lacking in thin spots from the resinous blends. Propylene polymer components 10 of greater melt viscosity, e.g. having melt flow rates below about 2 g/10 minutes, are more difficult to disperse in the poly(ethylene terephthalate) component and give extruded films having a rough and grainy texture poorly suited for use according to the invention. Degradation of the propylene polymer component during processing may result in melt flow rate increases to up to about two times that of the starting material. Low melt viscosity propylene polymer components, e.g. those with melt flow rates above about 18 15 g/10 minutes, provide insufficient melt strength to the resinous blend during film extrusion and result in weak films with thin spots and non-uniform thickness.

Preferably, the propylene polymer component has melt flow rate of about 3 to about 14 g/10 minutes according to ASTM D-1238 Condition L in order to attain good dispersion in the poly(ethylene terephthalate) component and facilitate extrusion of the blends into films of substantially uniform thickness, best results 20 being achieved at about 3.5 to about 5 g/10 minutes.

The invented yarns are prepared from a blend of components comprising poly(ethylene terephthalate) and propylene polymer components as described above in amounts such that about 17 to about 43 percent propylene polymer component is present by weight of the poly(ethylene terephthalate) component. Greater amounts of the propylene polymer component in the blends yield tape yarns that lack strength, fibrillate 25 excessively and are prone to dusting, making such yarns unsatisfactory for use in woven carpet backing structures. Below about 17 weight percent propylene polymer component, yarns have inadequate needle penetrability for tufting.

Preferably, to attain good processibility and yarns of suitable strength that can be woven into fabrics easily penetrated by needles during tufting operations without excessive fibrillation, the resin blends used 30 according to this invention contain about 20 to about 35 percent propylene polymer component by weight of the poly(ethylene terephthalate) component. More preferably about 25 to about 33 weight percent propylene polymer component is present.

Such resin blends can contain various additives and agents of the type commonly included in the individual resin components thereof. Examples include antioxidants, stabilizers, pigments, delusterants, etc.

35 The invented resin blends, comprising poly(ethylene terephthalate) and propylene polymer components as described above wherein about 17 to about 43 percent propylene polymer component, by weight of the poly(ethylene terephthalate) component, is present, are prepared by combining the resin components. Melt blending of the components, for example in an extruder, typically provides more uniform dispersion of the propylene polymer component in the blend than does dry blending. Dry blending prior to melt compound- 40 ing may facilitate the latter and yield a more uniform blend.

According to the invention, slit-film yarns suitable for weaving, and particularly well suited for use in manufacture of woven backing fabrics for carpets, are prepared by a process comprising (a) forming a molten, intimate mixture comprising a poly(ethylene terephthalate) component having intrinsic viscosity of about 0.7 to about 1.0 dl/g in o-chlorophenol according to ASTM D-2857 and about 17 to about 43 percent, 45 by weight of the poly(ethylene terephthalate) component, of a substantially crystalline propylene polymer component having a melt flow rate of about 2 to about 18 g/10 minutes according to ASTM D-1238 Condition L, such mixture being substantially free of water; (b) extruding the molten mixture through a film die onto a chill roll to obtain a quenched film of substantially uniform thickness; (c) slitting the quenched film along its length into a plurality of tapes; and (d) drawing the tapes at a draw ratio of about 4:1 to about 5.5:1. Preferably, to reduce shrinkage of the yarns to levels suited for tufted carpet tile and automotive 50 carpet backing structures, the drawn tapes are annealed.

The poly(ethylene terephthalate) and propylene polymer components used in the invented process are combined to form a mixture substantially free of water in order to avoid hydrolysis of the poly(ethylene terephthalate) component during processing and attendant loss of molecular weight and properties. Effects 55 of absorbed water on poly(ethylene terephthalate) and recommended drying procedures and conditions therefor are described in detail in "Goodyear Cleartuf Polyester Product Manual" issued by The Goodyear Tire and Rubber Company. As discussed therein, drying can be conducted in vacuum ovens, double cone rotary vacuum dryers, fluidized bed dryers, hopper dryers and dry air circulating or dehumidifying ovens.